Servo Motor

- What is a servo motor ?
- How do servo motors work ?
- Schematic diagram and operation analysis of the circuit.

What is a servo motor ?

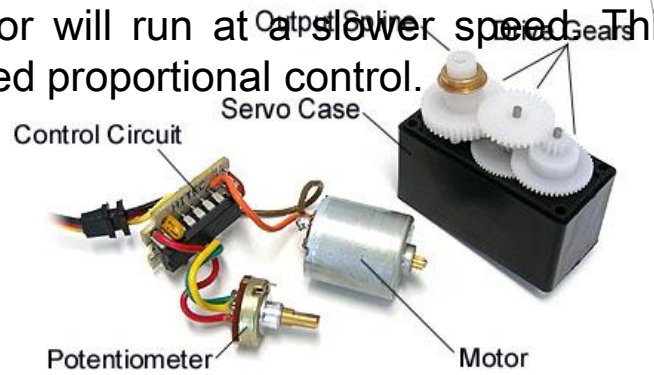
A Servo is a small device that incorporates a three wire DC motor, a gear train, a potentiometer,an integrated circuit, and an output shaft bearing (Shown in Figure). Of the three wires that stick out from the motor casing, one is for power, one is for ground, and one is a control input line. The shaft of the servo can be positioned to specific angular positions by sending a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. If the coded signal changes, then the angular position of the shaft changes.

Servos come in different sizes but use similar control schemes and are extremely useful in robotics. The motors are small and are extremely powerful for their size. It also draws power proportional to the mechanical load. A lightly loaded servo, therefore, doesn’t consume much energy.

A very common use of servos is in Radio Controlled models like cars, airplanes, robots, and puppets. They are also used in powerful heavy-duty sail boats. Servos are rated for Speed and Torque. Normally there are two servos of the same kind, one geared towards speed (sacrificing torque), and the other towards torque (sacrificing speed).

Servos are constructed from three basic pieces; a motor, a potentiometer (variable resister) that is connected to the output shaft, and a control board. The potentiometer allows the control circuitry to monitor the current angle of the servo motor. The motor, through a series of gears, turns the output shaft and the potentiometer simultaneously. The potentiometer is fed into the servo control circuit and when the control circuit detects that the position is correct, it stops the motor. If the control circuit detects that the angle is not correct, it will turn the motor the correct direction until the angle is correct. Normally a servo is used to control an angular motion of between 0 and 180 degrees. It is not mechanically capable (unless modified) of turning any farther due to the mechanical stop build on to the main output gear.

The amount of power applied to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. If it needs to turn only a small amount, the motor will run at a slower speed. This is called proportional control.



How do servo motors work ?

Servos are controlled by sending them a pulse of variable width. The control wire is used to send this pulse. The parameters for this pulse are that it has a minimum pulse, a maximum pulse, and a repetition rate. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in the clockwise direction as it does in the counter clockwise direction. It is important to note that different servos will have different constraints on their rotation but they all have a neutral position, and that position is always around 1.5 milliseconds (ms).

The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse width Modulation. The servo expects to see a pulse every 20 ms. The length of the pulse will determine how far the motor turns. For example, a 1.5 ms pulse will make the motor turn to the 90 degree position (neutral position).

When these servos are commanded to move they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.